

PSYCHOPHYSICS

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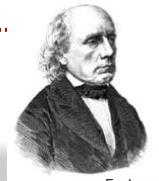
@peaclub



Where models can take us.

Qualitative → **Quantitative**

A trip back in time to 1860



Fechner

**Qualitative
Psychology**
*What I experience.
Mind.*

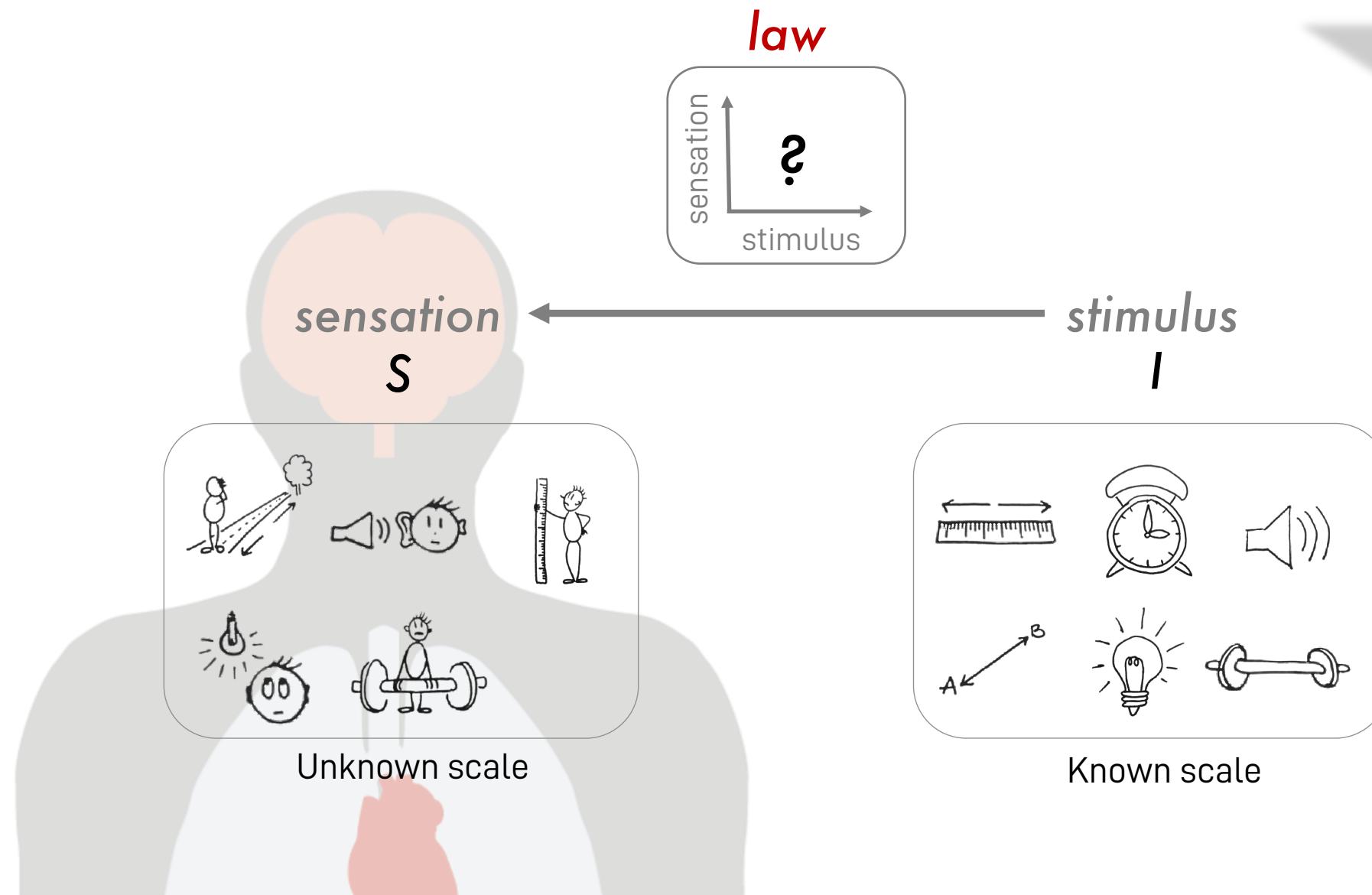
PsychoPhysics

**Quantitative
Physics**
*What is 'real'.
Matter.*

How do you measure sensation?



Fechner



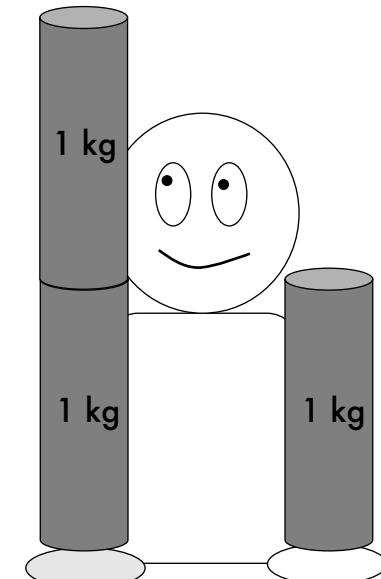
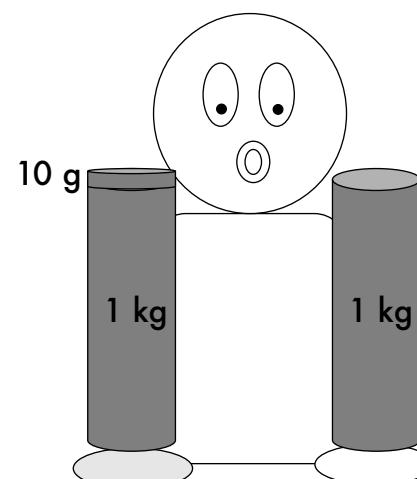
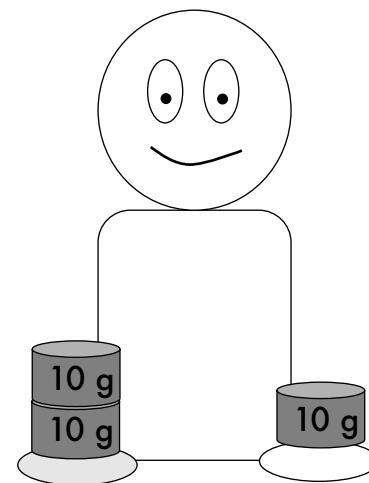


Weber

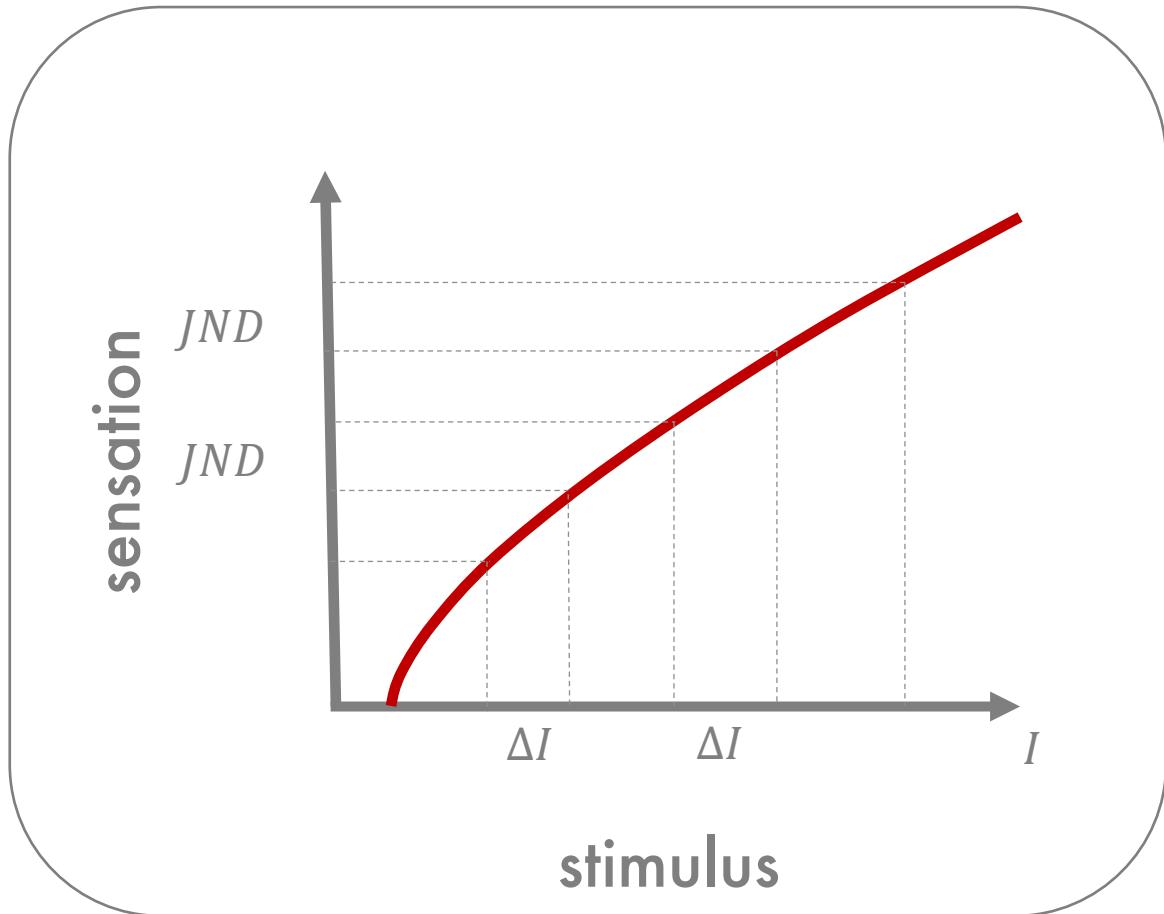
1834

Just-noticeable difference

$$\frac{\Delta I}{I} = k$$



Just-noticeable difference



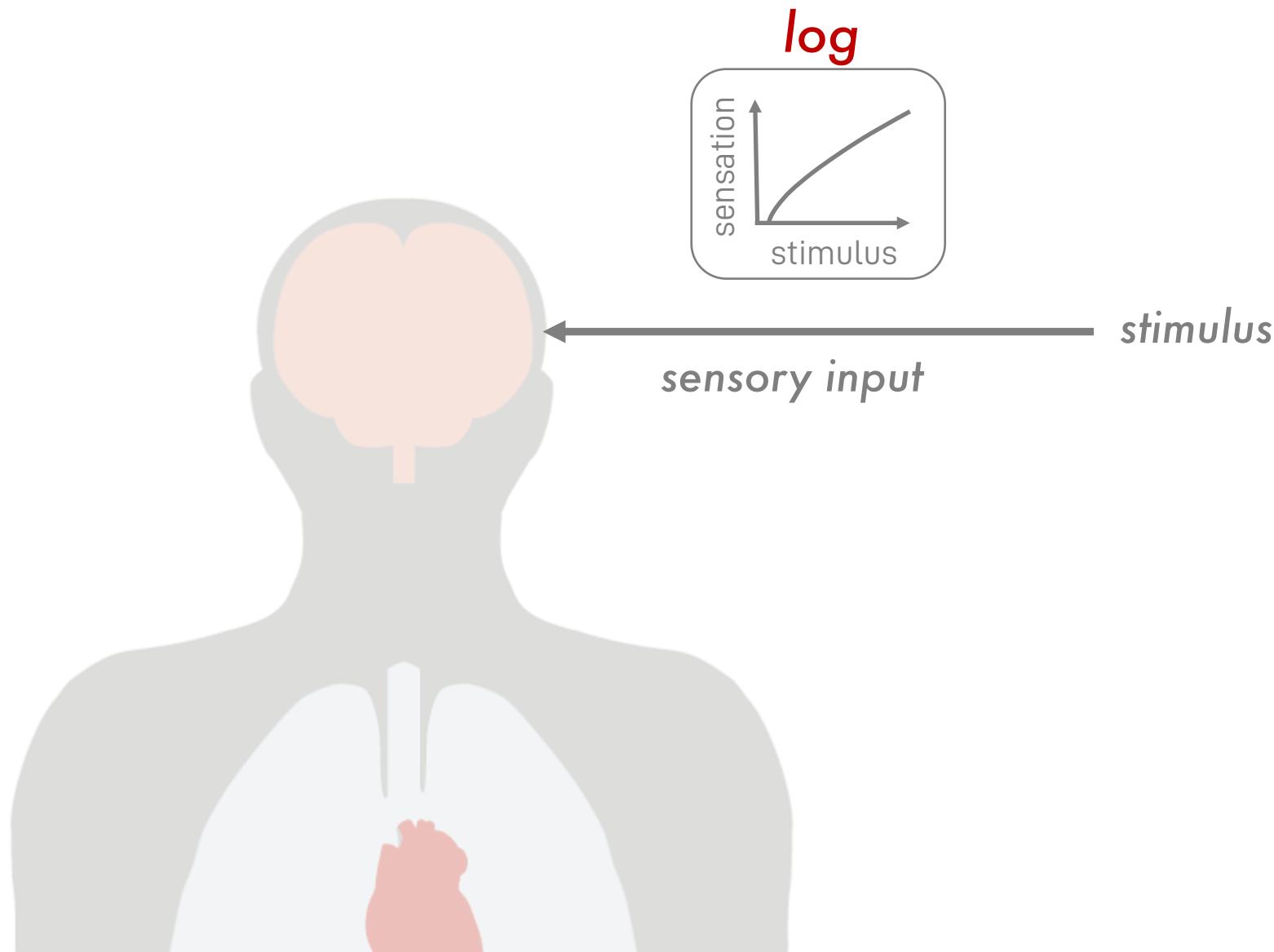
$$JND = \frac{\Delta I}{I} = k$$

$$S \propto \log I$$

Weber-Fechner Law



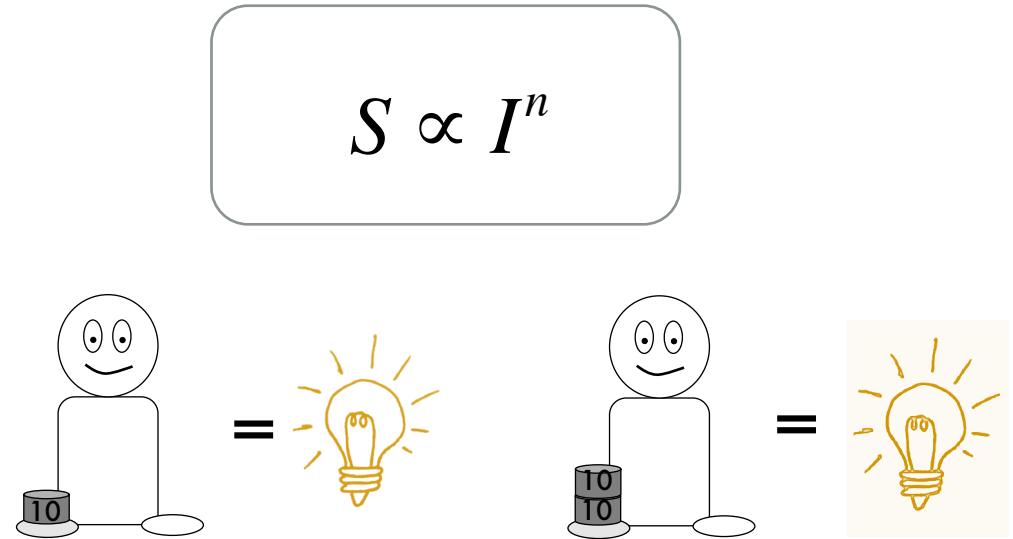
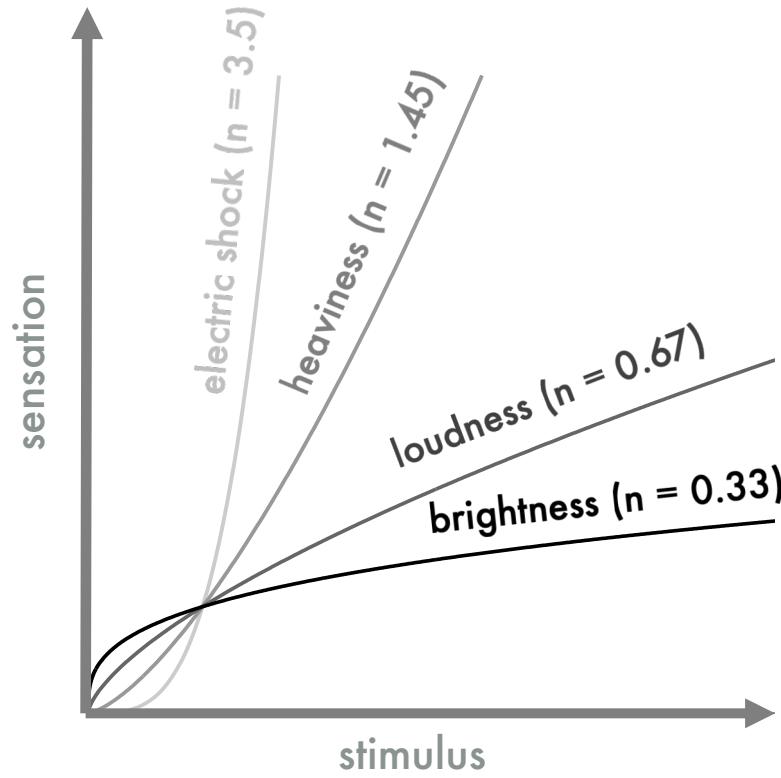
Psychophysical “LAW”



Steven's Power LAW

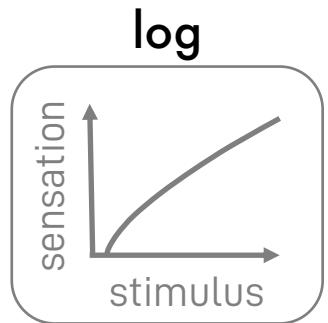


1961



The importance of measurements...

Weber-Fechner Law



Theoretically derived
Just noticeable difference ($I \rightarrow S$)

Steven's Power Law



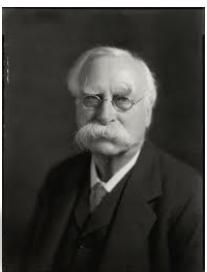
To Honor Fechner and
Repeal His Law

A power function, not a log function, describes the
operating characteristic of a sensory system.

S. S. Stevens

MacKay 1963, Science

Empirical
cross/modality matching ($I_1 \rightarrow S_1 \rightarrow S_2 \rightarrow I_2$)



Psychophysics
The new ~~Pseudophysics~~
E. Poulton
1968

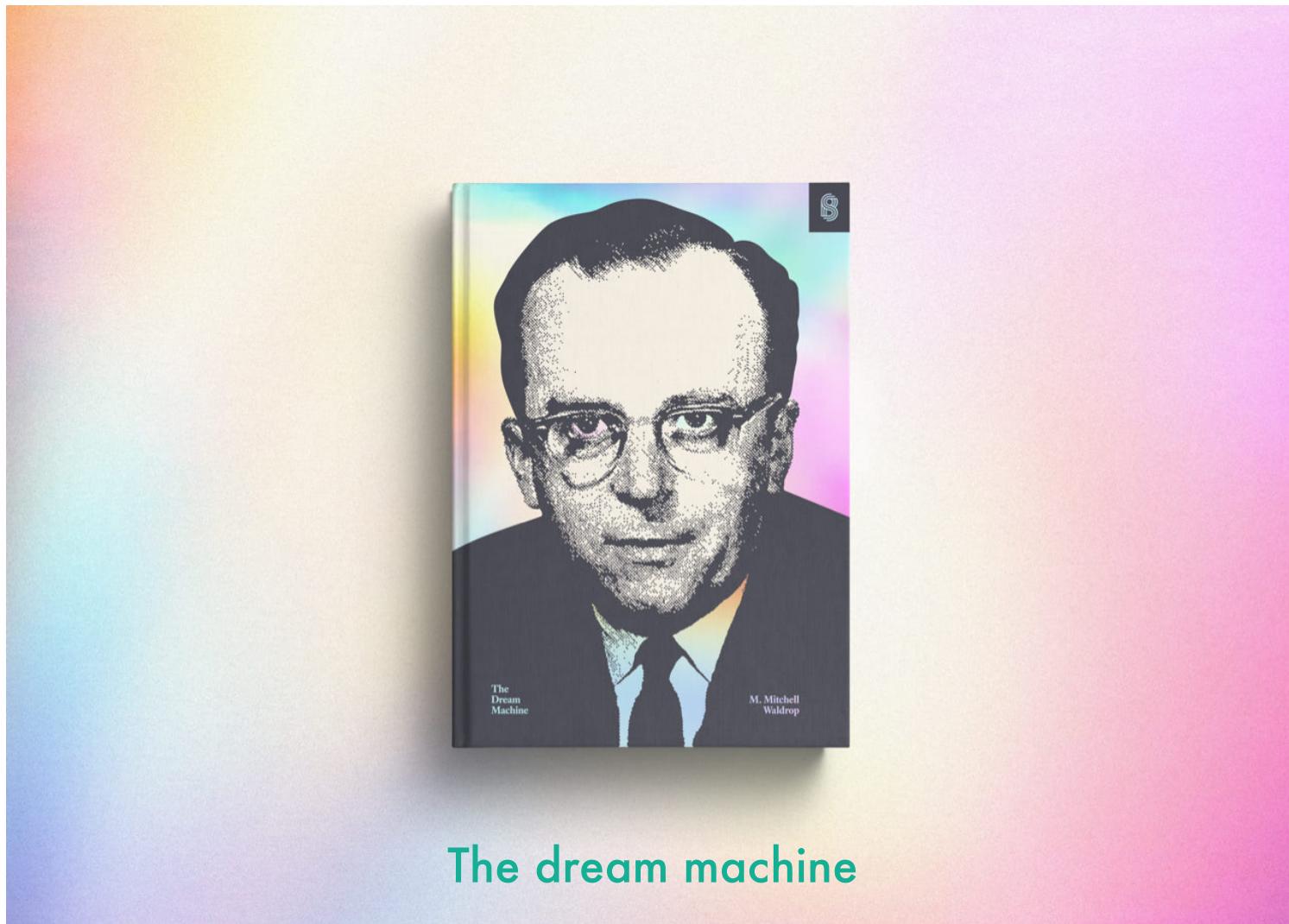


Next talk on
Bayesian
perception

E. Poulton

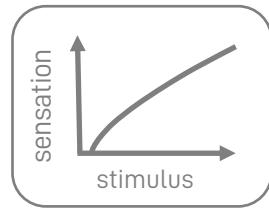
Side note

If you like science history



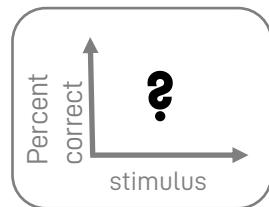
The dream machine

The importance of measurements...



Methods of adjustment/ estimation

- cross/unimodality matching
 - production – reproduction
- no right or wrong response!

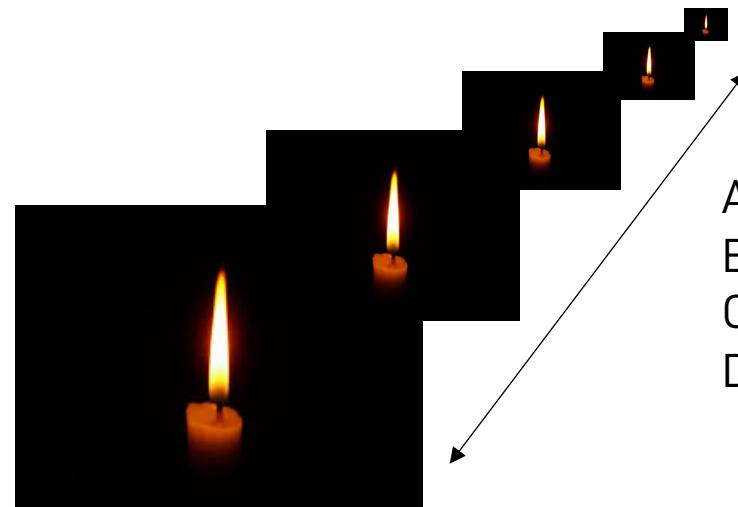


Methods of performance

- discrimination (e.g., bigger than)
- detection (yes/no)

Detection Threshold

How far can you still see a candle flame on a dark clear night?

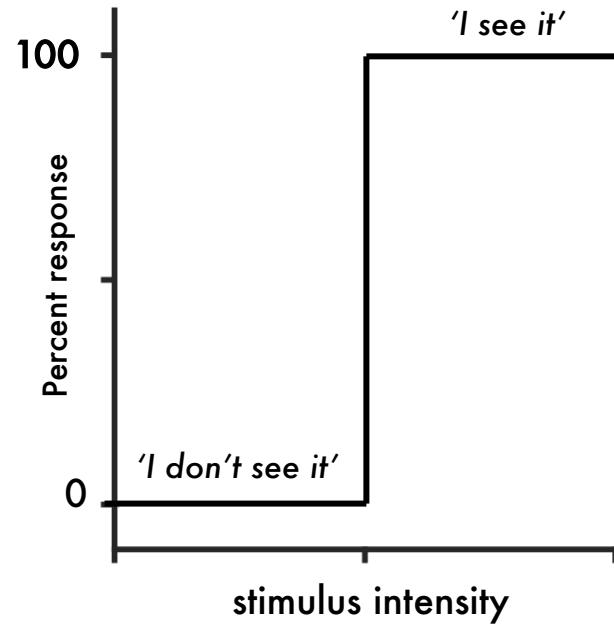


- A. 1 mile
- B. 3 miles
- C. 10 miles
- D. 30 miles

Estimating thresholds

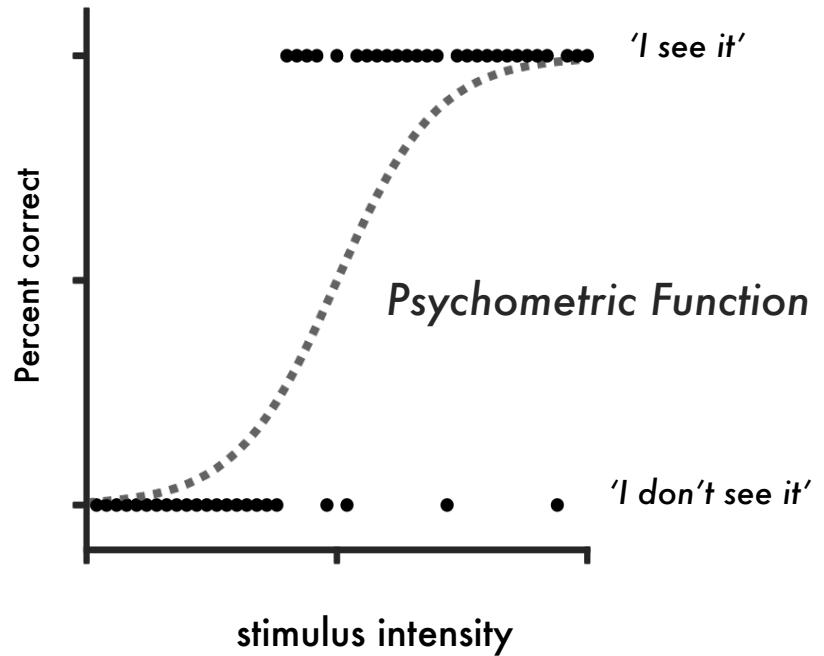
Was there a light? Yes or No.

Perfect Threshold



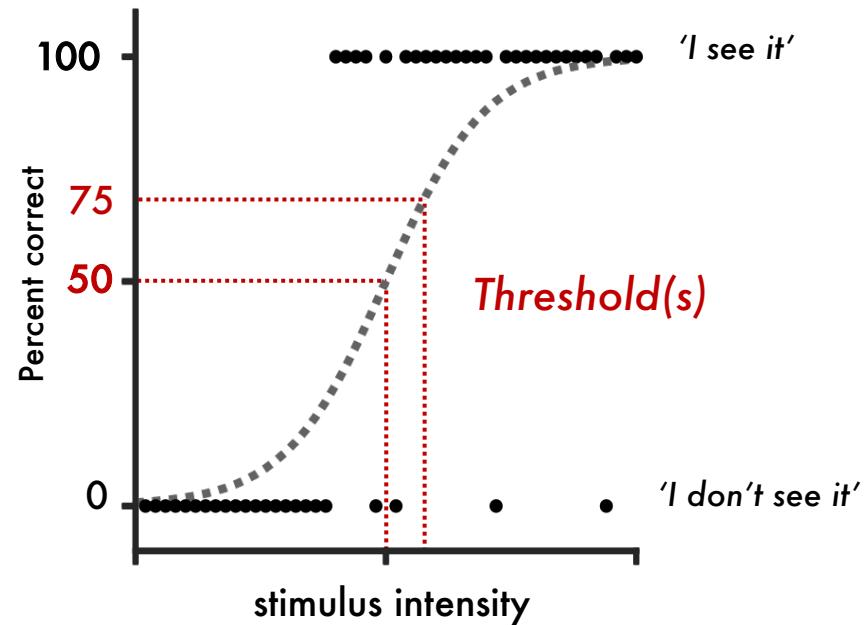
Estimating thresholds

Reality is noisy



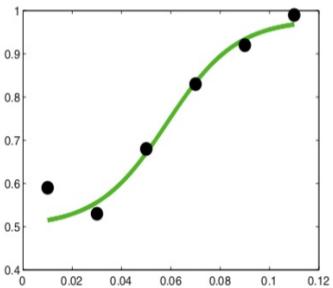
Estimating thresholds

Where is the threshold?



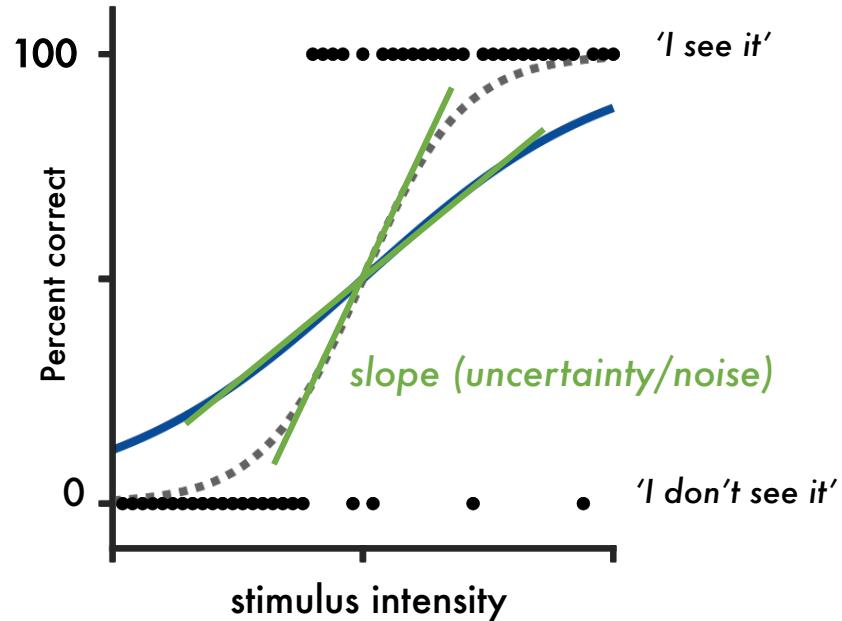
Fitting the psychometric function

Fitting the Psychometric function



- Cumulative Normal Distribution
- Logistic Function
- Weibull Function
- Cummulative Normal
- Gumble (Log-Weibull)
- Quick
- Hyperbolic Secant
-

Kingdom & Prins, Psychophysics, 2016



You can use Lionel's code to fit this function using ALL of the inference methods presented in this course: MLE, MAP, MCMC, VB
<http://github.com/lionel-rigoux/tutorial-bayesian-inference>

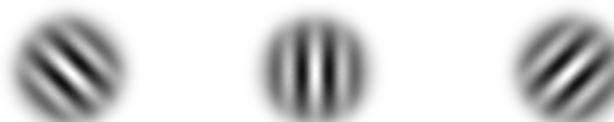
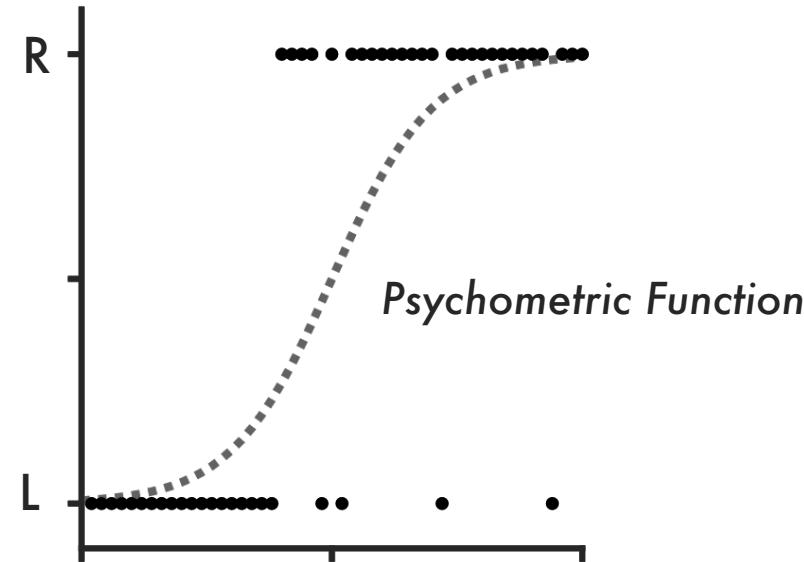
Psychometric function are universal

AFC: Alternative forced choice

1 AFC: Left-oblique or right-oblique?



2 AFC: Which one left-oblique?

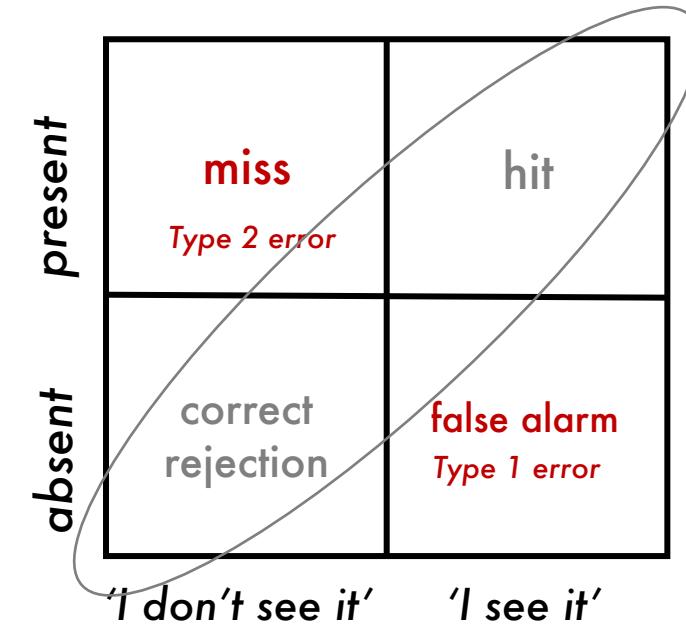
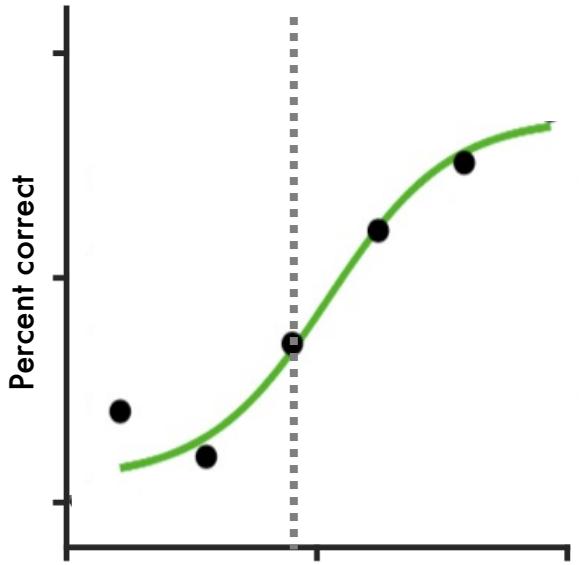


Relationship between physical quantity and detection/discrimination probability.

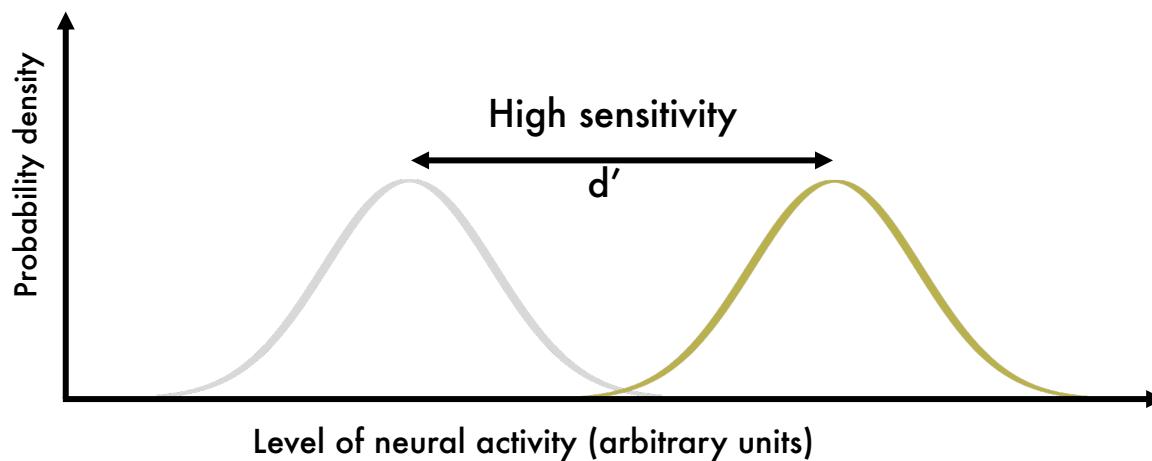
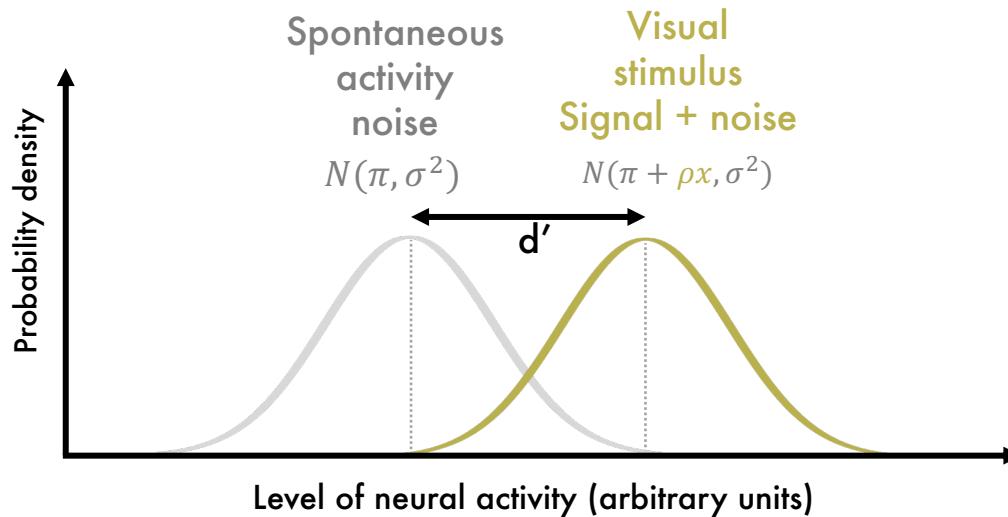
What is behind and beyond the Psychometric Function?

Signal detection theory

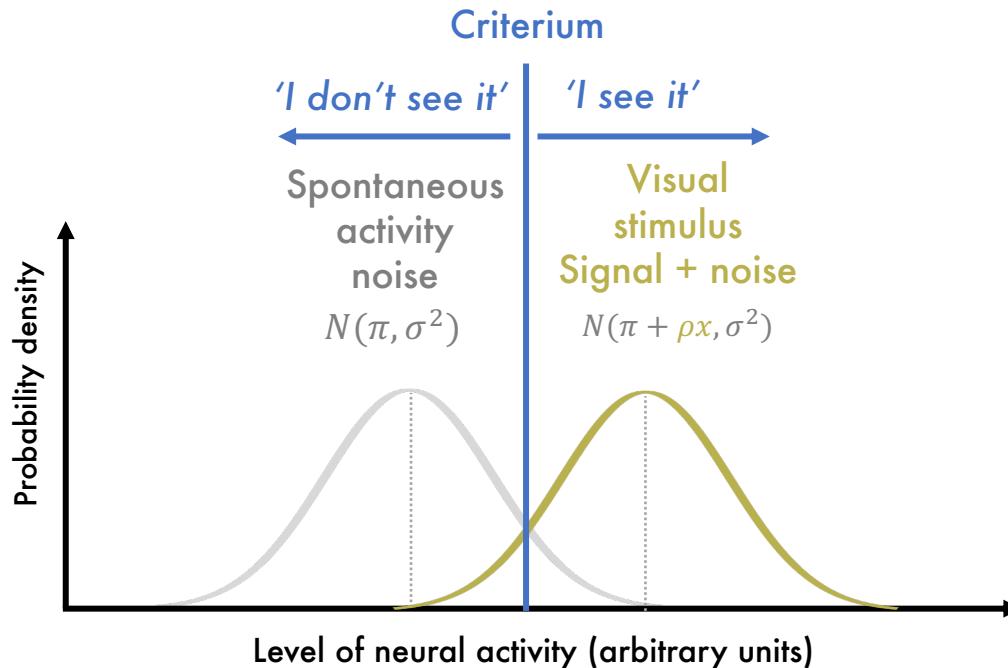
The details of probability correct



Signal detection theory

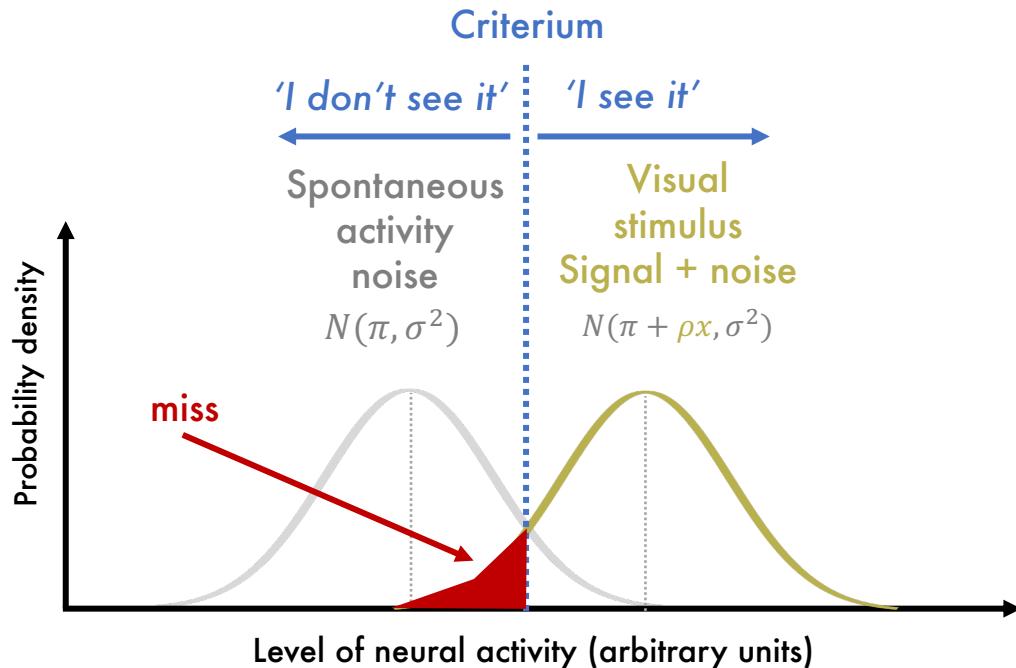


Signal detection theory



Criterium: Converting neural activity into an overt response

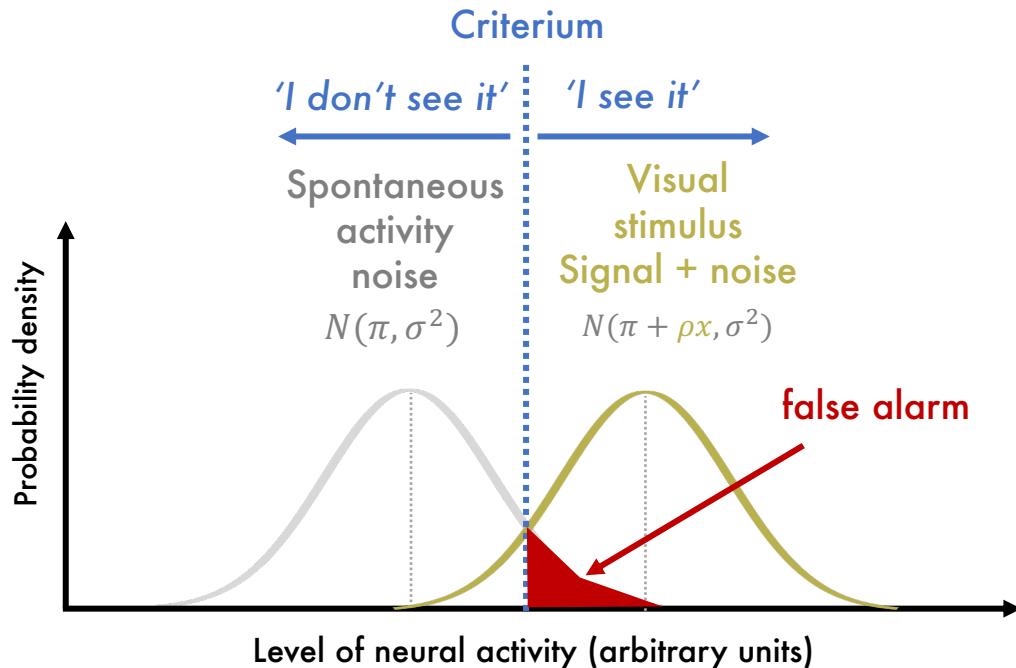
Signal detection theory



present	miss Type 2 error	hit
absent	correct rejection	false alarm Type 1 error

'I don't see it' 'I see it'

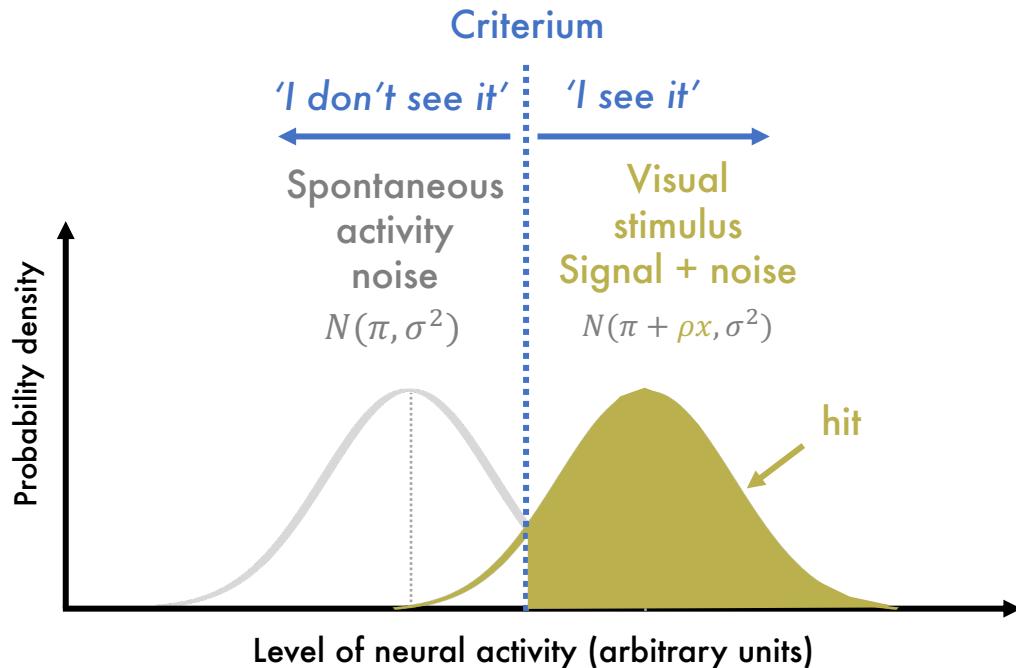
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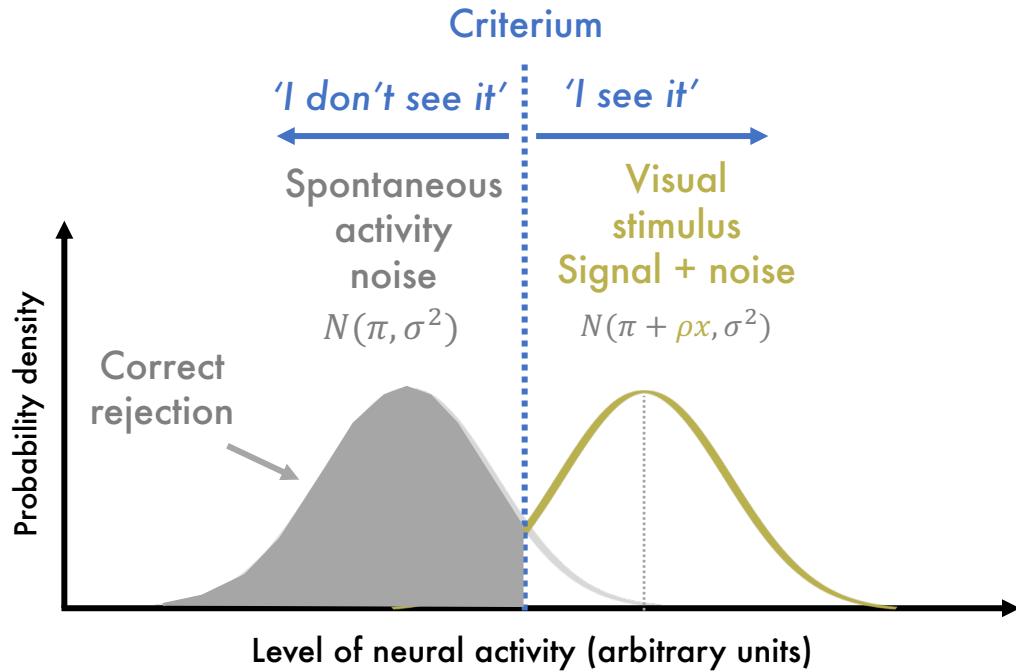
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Signal detection theory



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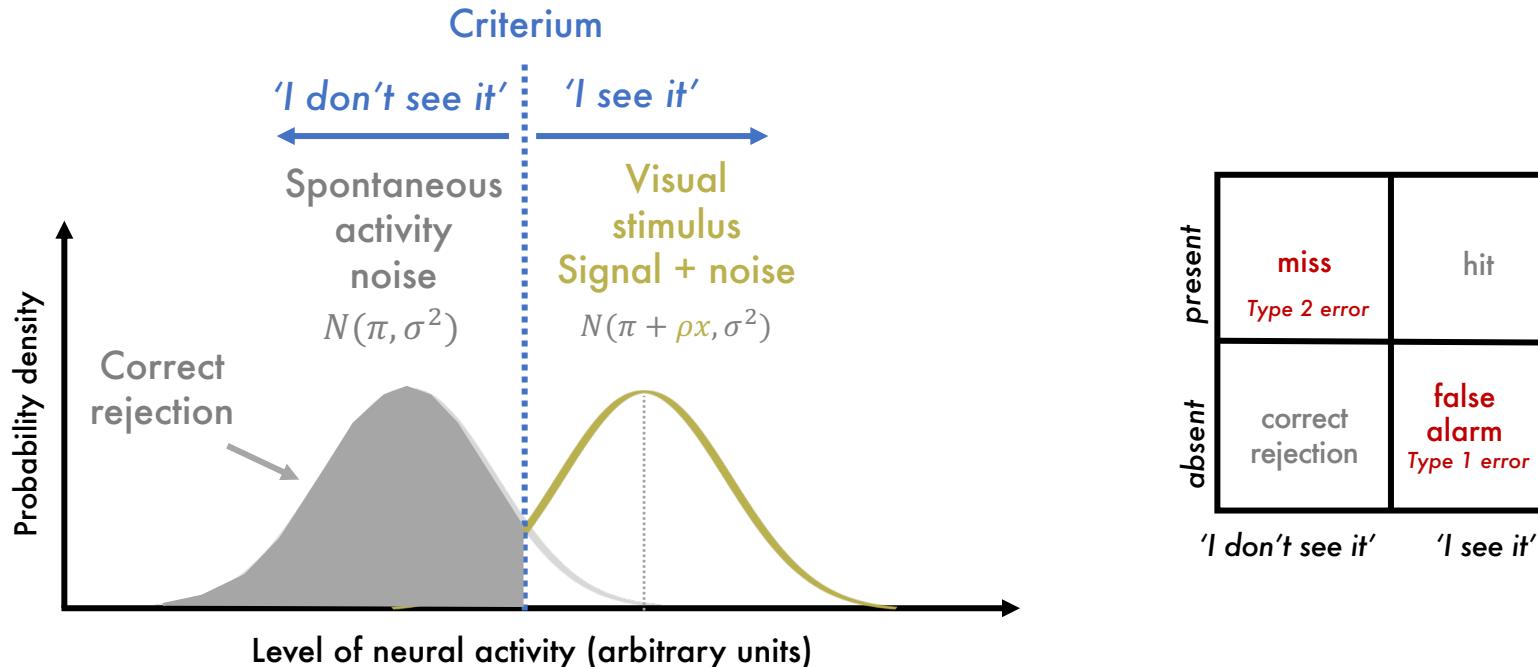
Signal detection theory

Calculating d' and bias

- Depends on the exact experiment 2AFC , 1AFC
- Conversion maps from PC to d'

Code & Formula
Kingdom & Prins, Psychophysics, 2016

McNicol (2004),
Chapters 5-8 Gescheider (1997)
Nonexpert: Macmillan and Creelman (2005)
More mathematical: Wickens (2002)
More mathematical: Green and Swets (1974)



present	miss Type 2 error	hit
absent	correct rejection	false alarm Type 1 error

'I don't see it' 'I see it'

$$2 \text{ AFC with bias: } d' = \frac{[z(pH) - z(pF)]}{\sqrt{2}}$$

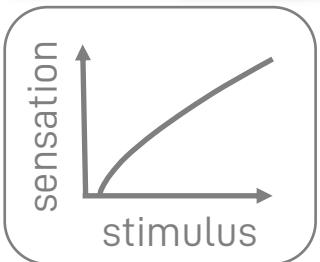
pH = Hit rate

pF = False alarm rate

z-score: transform into SD units

Summary

Weber-Fechner Law



Steven's Power Law

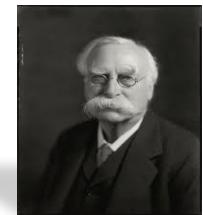


To Honor Fechner and Repeal His Law

A power function, not a log function, describes the operating characteristic of a sensory system.

S. S. Stevens

Methods of adjustment



Psychophysics

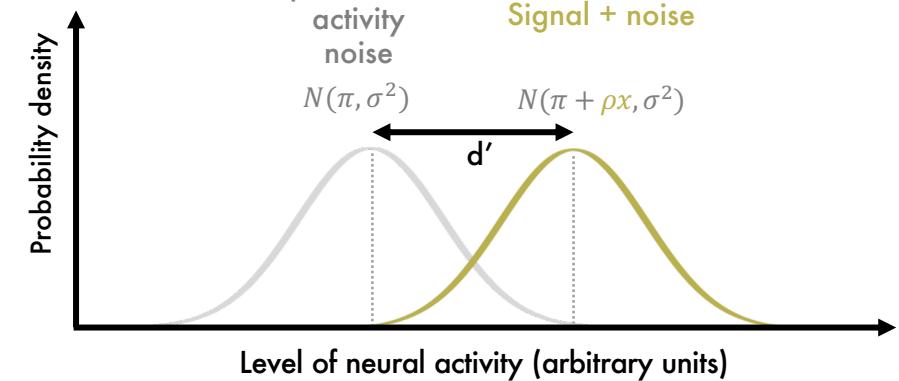
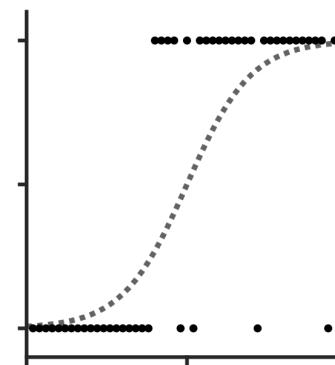
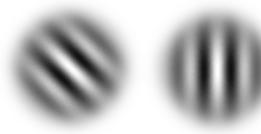
The new ~~Pseudophysics~~
E. Poulton
1968

Performance measures

1 AFC: Left-oblique or
right-oblique?



2 AFC: Which one
left-oblique?



Thank you

@rikepetzschn

@peaclub

Interested in working with us?

<https://fpetzschn.com/lab/>

Read Me:

Kingdom & Prins, Psychophysics, 2016

Petzschn et al., TiCS, 2015